Methylmercury Sorption, Uptake, and Degradation by Methanotrophs

BAOHUA GU[1*], XIA LU[1], WENYU GU[2], LINDUO ZHAO[1], MUHAMMAD FARHAN UL HAQUE[2], AND ALAN A. DISPIRITO[3], JEREMY D. SEMRAU[2]

[1] Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA
[2] Department of Civil and Environmental Engineering, the University of Michigan, Ann Arbor, MI 48109, USA
[3] Roy J. Carver Department of Biochemistry, Biophysics and Molecular Biology, Iowa State University, Ames, IA 50011, USA
(*correspondance: gub1@ornl.gov)

Microbial methylation and demethylation are two competing processes controlling the net production and bioaccumulation of neurotoxic methylmercury (CH_3Hg^+) in natural aquatic environments. While numerous studies have characterized the basis of mercury methylation, little attention has been given to the sorption, uptake, and degradation of CH_3Hg^+ by methanotrophs, despite their ubiquitous presence in the environment. We report that some methanotrophs such as *Methylosinus trichosporium* OB3b and *Methylocystis* SB2 can adsorb, take up, and degrade CH_3Hg^+ rapidly, whereas others such as *Methylococcus capsulatus* Bath and *Methylovulum miyakonense* can take up but not degrade CH_3Hg^+. Demethylation by *M. trichosporium* OB3b increases with increasing CH_3Hg^+ concentrations but was abolished in mutants deficient in the synthesis of methanobactin, a metal-binding compound used by some methanotrophs such as *M. trichosporium* OB3b. Further, addition of methanol (> 5 mM) as a competing one-carbon (C1) substrate inhibits demethylation, suggesting that CH_3Hg^+ degradation by methanotrophs may involve an initial bonding of CH_3Hg^+ by methanobactin followed by cleavage of the C–Hg bond in CH_3Hg^+ by the methanol dehydrogenase. These observations demonstrate a previously unknown but potentially important mechanism for CH_3Hg^+ detoxification and suggest possible broader involvement of C1-metabolizing aerobes in the degradation and cycling of toxic CH_3Hg^+ in the environment.